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| <b>14. ABSTRACT</b><br>The primary objective of this project was to provide the first experimental test of OT's possible causal role in the disinhibition of aggressive behavior in humans. This research was designed to investigate a likely hormonal link between a neurotransmitter implicated in coalition-building and increased willingness to engage in aggressive behavior. Potential applications of this research include increasing our ability to predict and influence aggressiveness by better understanding the interaction between group cohesion, trust, and moral leadership on coalitional violence. The purpose of this research was to investigate the role of the hormone oxytocin (OT) on the aggressive behaviour of men and lactating or non-lactating women. In addition, the relationship of fear to aggressive behaviour was also investigated. Using measures of blood pressure, heart rate, salivary oxytocin, and vigilance toward threatening faces we found that lactational status alone increased aggression. We also found that lactating women were more aggressive than both the never-pregnant female control group and non-lactating mothers. |                              |                                       |  |  |  |
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## **Final Performance Report for Grant Number FA8655-09-1-3065**

*Title:* Neural Correlates of Coalitionary and Violent Behavior Tendencies

*Primary Investigator:* Professor E. Thomas Lawson, Queen's University - Belfast

### **Summary**

The purpose of this research was to investigate the role of the hormone oxytocin (OT) on the aggressive behaviour of men and lactating or non-lactating women. In addition, the relationship of fear to aggressive behaviour was also investigated. Using measures of blood pressure, heart rate, salivary oxytocin, and vigilance toward threatening faces we found that lactational status alone increased aggression. We also found that lactating women were more aggressive than both the never-pregnant female control group and non-lactating mothers.

### **Introduction**

The primary objective of this project was to provide the first experimental test of OT's possible causal role in the disinhibition of aggressive behavior in humans. This research was designed to investigate a likely hormonal link between a neurotransmitter implicated in coalition-building and increased willingness to engage in aggressive behavior. Potential applications of this research include increasing our ability to predict and influence aggressiveness by better understanding the interaction between group cohesion, trust, and moral leadership on coalitional violence.

### **Method**

Subjects: 18 lactating mothers, 17 formula-feeding mothers, 19 never-pregnant female controls, and 20 male controls. Protocol: Measures of aggression, BP and autonomic response to threat-relevant social stimuli were taken before and after OT levels are experimentally manipulated by asking lactating mothers (the high OT releasing group) and formula-feeding mothers (the low OT releasing group) to feed their infants both before and after an aggressive encounter. The never-pregnant female and male groups provided a control condition (the no OT releasing controls. )

### **Results**

The only significant difference in aggression between groups found was that lactating mothers entered higher sound volumes than formula feeding mothers. The data indicated that among participant variables only relationship status and breastfeeding status were significant predictors of aggression. When investigating whether lactation acted as a buffer to autonomic arousal during an aggressive encounter we found that lactating mothers exhibited less change in heart-rate than the never-pregnant female controls during the aggressive encounter, as well as having lower diastolic and systolic blood pressure throughout the experimental procedure than non-lactating women. Males had higher systolic and diastolic blood pressure and larger changes in these variables from baseline to the aggressive encounter than all of the other groups of women. There were significant correlations between diastolic blood pressure and aggression for both the male and female control groups. Males with higher BP were more aggressive, whereas women with high BP were less aggressive. Both the lactating and formula feeding mother's BP scores were not correlated with aggression, however, when all female participants were collapsed into one group, a similar significant inverse correlation between BP and aggression was observed. Males were significantly vigilant toward the angry face during the first reaction time competition, but not during the second and lactating mothers showed a marginally significant vigilance toward the angry faces throughout the competition indicating differences in pre-attentive processing bias towards threat-related stimuli between these groups. Female controls and formula-feeders were not significantly different from zero either pre- or post- feeding or during the competition. There were no significant correlations between pre-attentive bias towards threat and aggression for any of the groups.

### **Discussion**

At present, this study has provided the first evidence of lactation-induced heightened aggression in humans. The primary finding was that breastfeeding mothers chose significantly louder retaliatory sound-burst volumes than bottle-feeding mothers. Moreover, breastfeeding mothers were more aggressive than the female control group when the variance attributed to relationship status was accounted for. In addition, arousal and

aggression were related quite differently according to gender: male aggression *positively* correlated with arousal and female aggression levels were *inversely* correlated with arousal.

### **Conclusion**

The present data supports the hypothesis that diminished fear is correlated with increased aggression in women. Importantly, the opposite pattern, increased cardiac arousal leading to increased aggression, was observed in men. Additionally, lactation in this study was found to increase aggression in women. Future research might be directed at parsing the proximal biological mediator(s) of this behavioral shift.

### **Final Updated Deliverables**

The manuscript resulting from the research supported by the grant was submitted to *Nature* co-authored by Jennifer Hahn-Holbrook, Julianne Holt-Lunstad, Colin Holbrook, and Sarah Coyne. The article discusses the fact that mothers across numerous mammalian species exhibit heightened aggression towards conspecifics and predators coinciding with the course of lactation. It has been posited that maternal aggression has evolved to defend offspring. In rodents, this shift in aggression has been suggested to be facilitated by the suppression of autonomic fear responses to threats which accompanies lactation. Maternal aggression remains virtually unexplored in humans. In the article we reported the first behavioural evidence for lactation-induced heightened aggression in humans. Breastfeeding mothers inflicted louder and longer white noise bursts on unduly aggressive confederates in a competitive task than formula-feeding mothers or never-pregnant women. We found mixed support for the hypothesis that decreased fear facilitates aggression during lactation. Lactating women exhibited lower levels of autonomic arousal (as measured by systolic blood pressure) than non-lactating mothers during the aggressive encounter. Additionally, blood pressure was inversely correlated with aggression for the women in our sample as a whole, indicating that reduced stress facilitates female aggression. However, blood pressure did not significantly correlate with the aggression of lactating mothers.

The article is through the first stage of evaluation and is now in the hands of external reviewers. (draft manuscript is attached)